

dimethacrylate such as polyethylene glycol diacrylate, polyethylene glycol dimethacrylate, polypropylene glycol diacrylate and polypropylene glycol dimethacrylate. The average molecular weight of the polyalkylene glycol diacrylate or polyalkylene glycol dimethacrylate is preferably 300 to 1,600. When the average molecular weight thereof is less than 300, the host polymer has an insufficient gel-forming ability, and when the average molecular weight is more than 1,600, the host polymer has a decreased stability at high temperatures.

The above copolymer can be obtained, for example, by oxidizing polyvinylidene fluoride to introduce an oxygen-containing group such as an OH group, COOH group and O₂ radical group, and reacting such oxygen-containing group with a polyalkylene glycol diacrylate or polyalkylene glycol dimethacrylate.

An example of a method for producing the above copolymer will be described.

First, polyvinylidene fluoride (average molecular weight: 100,000 to 1,000,000) is dissolved in N-methyl-2-pirrolidone (hereinafter referred to NMP) in a reactor, and polyvinylidene fluoride is subjected to oxidation reaction under oxygen bubbling at 50 to 90 °C, preferably at about 70 °C for 6 to 72 hours, preferably for about 24 hours.

Later-described modified polyvinylidene fluoride having an oxygen-containing group and a modified vinylidene fluoride-hexafluoropropylene copolymer having an oxygen-

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containing group that are used as an electrode binder can be obtained by the above-mentioned method.

Thereafter, polyethylene glycol diacrylate having an average molecular weight of about 1,100, for example, is added to the aforementioned reactor and reacted for 3 to 48 hours, preferably for about 12 hours. The amount of polyethylene glycol diacrylate reacted with the polyvinylidene fluoride can be readily evaluated by the change of weight from the weight of polyvinylidene fluoride before the reaction to the weight of the copolymer obtained after the reaction.

The reaction of polyethylene glycol diacrylate with polyvinylidene fluoride may be carried out under the presence of an alkaline substance such as amines, under an oxygen atmosphere or under the irradiation of electron beam after preparing a homogenous solution containing polyethylene glycol diacrylate and polyvinylidene fluoride.

Next, an example of a method for forming a separator comprising a gel electrolyte will be described.

First, an inorganic filler and the aforementioned copolymer are dispersed in NMP to prepare a slurry. The amount used of the inorganic filler is 10 to 100 parts by weight per 100 parts by weight of the copolymer, and the amount used of NMP is 100 to 500 parts by weight per 100 parts by weight of the copolymer.

As the inorganic filler, fine powders of silicon dioxide, aluminum oxide and the like subjected to hydrophobic

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treatment on the surface thereof can be used. Next, the above slurry is applied onto both surfaces of the negative electrode and dried to form separator layers containing the inorganic filler and the copolymer.

This negative electrode and the positive electrode are laminated with the separator layer interposed therebetween, and rolled up to prepare an electrode assembly. After housing the electrode assembly into a battery case, a liquid organic electrolyte mixed with 0.01 to 1 wt%, preferably about 0.1 wt% of a thermal polymerization initiator relative to the weight of the copolymer is poured under reduced pressure into the battery case, and then the battery case is sealed. As the thermal polymerization initiator, 2,2'-azobis-2,4-dimethylvaleronitrile (trade name: V-65, manufactured by Wako Pure Chemical Industries, Ltd.) or the like is preferred. Then, by heating the sealed battery at 50 to 80 °C, preferably at about 70 °C for 15 minutes to 4 hours, preferably for about 1 hour, the copolymer in the separator layer is crosslinked and the separator comprising a gel electrolyte is formed in the battery.

The positive electrode and the negative electrode contain an active material and a binder. As the positive electrode active material, lithium-containing complex oxides such as LiCoO_2 , LiNiO_2 , LiMn_2O_4 , LiMnO_2 and LiV_3O_8 are used, for example. As the negative electrode active material, carbon materials such as natural graphite, artificial graphite